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The DOD Acquisition/Test Process: What Went Wrong and How to Fix the Process

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This article summarizes the changes to the acquisition/test processes since the mid-1990s and the impact of those changes. The way to judge the effectiveness of any set of initiatives is to assess outcomes. The changes of the last 15 years, in the aggregate, have had a significant negative impact on weapons system acquisition programs in terms of cost overruns, accompanied by increased developmental time lines, as well as a dramatic increase in suitability (reliability, availability, and maintainability) failure rates. The motivation for many of the changes was to correct an overly bureaucratic and time-consuming process by adopting commercial practices and allowing more flexibility. The outcome, with few exceptions, was the removal of a disciplined process, albeit with defects, but which incorporated lessons learned over decades, without substituting a disciplined alternative. At the same time, an experienced government workforce was decimated, and some guidance documents necessary to manage a more flexible alternative acquisition process were either done away with or allowed to atrophy. By doing away with processes and guidance documents that have evolved over decades at a time when acquisition programs were becoming increasingly complex and interrelated, Department of Defense (DoD) effectively threw out the playbook and at the same time got rid of the majority of its most experienced players. A discussion of the remedies required to improve the process follows a discussion of the problems. While the article is Test and Evaluation (T&E) centric, it addresses other aspects of the acquisition process as well.

Key words: Acquisition process reform; test and evaluation; commercial standards; military specifications; modeling & simulation; reliability; suitability failure; sustainment costs; workforce reduction.

For a period of 40 years or more, the DoD acquisition process was focused on acquiring systems to meet a single potent but relatively well-defined threat. The acquisition process that evolved during that period developed and delivered a succession of the most capable weapons systems in the world, albeit not without problems. With the collapse of the Soviet Union and Warsaw Pact, the national focus of the U.S. shifted to other priorities. There was a "procurement holiday" during the 1990s, and several waves of "acquisition reforms" followed, with mixed results. This article explores what happened during the last 2 decades, through a prism of Test and Evaluation (T&E), and identifies remedies to correct some of the problems that have crept into the system.

What happened?

Threat changes

The nature of the threat has changed dramatically since the demise of the Soviet Union. A set of totally different asymmetric threats has arisen in a very short period of time, which drives many "quick reaction" developmental programs. At the same time, the requirement to develop more capable follow-on weapons to the systems fielded in the last several decades still exists.

Breakthroughs in communications techniques, aided by much more capable and inexpensive information processing technology, provide the potential for much better interoperability at all levels; e.g., coalition, joint, system-of-systems. This is a huge challenge because for decades the acquisition process was focused on optimizing designs at the system level as well as for a monolithic threat. Rapid information technology advances in the commercial world became an impetus to adapt commercial approaches to the DoD acquisition process and probably served as a catalyst to decrease government oversight.

Congressional actions

Congressional direction in Fiscal years 1996 through 1999 Defense Authorization Acts reduced the acqui-

sition workforce. In addition, Congress promoted the use of non-government standards in federal agencies in the National Technology Transfer Act.[1]

Acquisition reform

Several changes resulted from the implementation of acquisition reform in the late 1990s. While the acquisition reform initiatives were well intentioned, in some instances they had detrimental results because of the manner in which they were implemented.

The defense industry was encouraged to use commercial specifications and standards, unless there was justification for the use of military specifications.[2] This policy sometimes resulted in inappropriate use of commercial standards, and numerous military specifications and standards were either cancelled or fell into disuse in Service acquisition organizations. Allowing more flexibility by selective use of commercial specifications and products is a sound concept where appropriate for military applications. However, implementing this process effectively requires capable and experienced government engineering and contracting experts. The acquisition/developmental test workforce required to implement this approach was decimated by congressional cuts, accompanied by additional excessive cuts by many Service acquisition organizations. It has certainly been the case in some instances that an overly stifling DoD oversight environment contributed to cost growth, schedule slips, and constrained innovation. There were instances when specifications were applied inappropriately because they had not been adequately tailored to the system under procurement. However, most specifications had evolved over decades and were excellent compendiums of best practices and lessons learned.

The author has personal experience with developing and updating specifications and standards. The process typically includes government domain engineers, leading independent research laboratory personnel, as well as domain design experts from the defense industry. Specifications are used in conjunction with the initial requirements process to help define basic design and test requirements. They facilitate a disciplined approach to requirements definition, and help ensure that the normal developmental challenges that occur in any new highly complex high technology system are uncovered early.

In addition to the cancellation of design/test specifications, other acquisition guidance documents fell into disuse. One major acquisition organization estimated that 80 percent of these documents have not been updated and thereby have been allowed to atrophy. By doing away with guidance documents and processes that have evolved over decades, at a time when acquisition programs were becoming increasingly complex and interrelated, DoD effectively threw out the playbook and at the same time got rid of the majority of their most experienced players.

Reliability/sustainment cost impacts

One major casualty of acquisition reform was that basic military reliability specification was cancelled, and the requirement for a reliability growth program during development was eliminated in all but a small fraction of DoD acquisition programs. This resulted in a significant increase in the number of programs not meeting minimum reliability and maintainability thresholds during initial operational test and evaluation (IOT&E).[3] More important, it resulted in a significant negative impact in the availability of fielded systems as well as substantial increases in sustainment costs, which translates directly into increased life cycle costs. Recent case studies conducted by the Logistics Management Institute (LMI)[4] and the Army[5] show that a robust investment in reliability during program development results in a significant reduction in sustainment cost.

Acquisition process turbulence

There were several initiatives over the last 15 to 20 years that contributed to acquisition process turbulence. These have been characterized as slogan-based acquisition experiments; starting with "Simulation-Based" in the early 1990s; followed in rapid succession by "Performance-Based"; "Capability-Based"; and "Effects-Based." The use of Modeling and Simulation (M&S) received additional impetus starting in the early 1990s with advances in information processing technology. However, the potential for improving the acquisition process was grossly oversold, with expectations unduly raised by many government managers. M&S tools have been used for decades in support of the development/test process. It is no substitute for robust testing of production representative articles throughout the operating envelope; but can be a valuable adjunct to certain types of developmental and operational test activities. In many cases, this requires the development of physics-based models, followed by an iterative comparison of predicted results with actual test data; with adjustments made to models as necessary. Projections to untested conditions usually involves extrapolations, which are sometimes limited by an understanding of the physics involved when moving from one regime to another, as well as the interaction of many complex phenomena. The data processing system must be compatible with the simulation tools to facilitate interaction among testing, simulation, and analysis tools.

The information processing advances of the 1990s greatly enhanced the realism of environments used in test and training simulators. However, many of the joint M&S activities initiated in the past 15 years were disjointed, with few notable successes in building and sharing common models, databases, and verification and validation efforts, all of which are required to ensure the new models are adequate for the intended purpose. Numerous recent M&S developments were terminated after investing tens of millions of dollars because of the failure to produce a useable product. In addition, because of recent acquisition process changes relating to model and test data availability, models and simulations were often not updated and contractor and relevant commercial models sometimes not made available to government organizations.

Service test/test support workforce reductions

The manpower reductions mandated by Congress in the late 1990s, followed by excessive additional Services-directed reductions have decimated the program office engineering and test support workforce as well as DoD government test organization personnel. One of the participants in a recent study observed that the government test community has gone from "insight" to "oversight" to "out-of-sight." The major changes to the DoD test workforce are detailed in the May 2008, *Report of the Defense Science Board Task Force on Developmental Test and Evaluation*[3] and are summarized below. All Services took the congressionally legislated acquisition/test workforce reductions. Some Service acquisition organizations, notably in the U.S. Air Force, went well beyond the mandated cuts.

Army. The U.S. Army declared that government involvement in developmental testing is optional and all but eliminated their military test cadre several years ago. A brigade combat team was subsequently stood up at Fort Bliss to support Future Combat System testing.

Navy. The U.S. Navy retained government involvement in the T&E process to a greater degree than did the Army and the Air Force.

Air Force. The current trend in the Air Force is to turn Developmental Test & Evaluation (DT&E) over to the prime contractor. Some Air Force acquisition organizations reduced the technical personnel supporting program offices by as much as 60 percent. These were cuts to subject matter experts who previously assisted in translating requirements into design specifications, as well as overseeing the technical progress of developmental programs.

Office of the Secretary of Defense (OSD). Director of Operational Test and Evaluation (DOTE): There have been no significant cuts or mission changes to the office of DOTE. Director of Developmental Test & Evaluation: The OSD office responsible for developmental test and evaluation was dismantled in 1999. Since that time, there has been no effective OSD oversight of developmental test and evaluation programs, practices or workforce training.

Major Range and Test Facility Base (MRTFB). The focus of investment in DoD's in-house T&E capabilities is the MRTFB, which comprises those facilities, ranges, and skilled personnel designated as most critical to supporting the developmental test and evaluation needs for DoD acquisition programs. Another change resulting from recent acquisition policy revisions was a de-emphasis in the use of government test facilities. As a result of these policy changes and attendant manpower cuts, the MRTFB has experienced the loss of a large number of experienced subject matter engineering experts, scientific and information technology personnel. Additionally, several MRTFB test facilities have been or are being mothballed or closed, while few significant new capabilities have been added in the past fifteen years.

Aggregate impact of changes

The changes discussed above, in the aggregate, had a substantial negative impact on the DoD acquisition process. It should be reiterated that some of the basic objectives of the initiatives were sound, but the implementation was significantly flawed for numerous reasons, which are discussed in this article. The chief reason is that government involvement and oversight throughout the process from initial requirements setting to system fielding was inadequate. The way to judge the effectiveness of any set of initiatives is to look at results. A number of outcomes that indicate the lack of effectiveness are summarized below:

- inadequate requirements definition,
  - increased requirements turbulence,
  - testability considerations deemphasized,
- inadequate attention to technology readiness,
- cost overruns unprecedented in magnitude and frequency of occurrence,
  - numerous Nunn-McCurdy breaches: precipitated "Triage action,"
- developmental time lines increased,
  - unprecedented schedule slips,
- dramatic increase in suitability failure rates,

- major sustainment cost, system availability driver,

- waivers granted for not meeting critical technical parameters,
- production increments increasingly funded prior to initial operational test and evaluation (IOT&E) or adequate DT&E.

The time line increase is the result of numerous factors, including lack of discipline in the initial requirements process, frequently changing requirements, underfunding developmental programs from the outset, and a lack of discipline in assessing technology readiness.

Congressional legislation

The situation became so bad without effective corrective action by OSD or the Services that Congress took the initiative, starting with Senate and House Armed Services Committee hearings in March 2009, followed by legislation in May (Public Law 111-23; May 22, 2009 "Weapon System Acquisition Reform Act of 2009"), which is designed to correct what Congress perceived as the major deficiencies in the current acquisition process. Among other actions, the legislation mandates

- the establishment of a Director of Cost Assessment and Program Evaluation,
- reestablishment of the Director of Developmental Test & Evaluation (DDT&E), to be principal advisor to the Secretary of Defense and Under Secretary of Defense (Acquisition, Technology & Logistics) on DT&E, and
- establishment of the Director, Systems Engineering (SE), with comparable responsibilities relative to Systems Engineering.

The key policy provisions include a requirement for a trade-off analysis among cost, schedule, and performance, prototyping critical technologies and actions to address systemic problems. Statutory requirements for the DDT&E include a joint annual report to Congress with the Director SE on DT&E and SE activities, and collaboration with the Director Defense Research & Engineering (DDR&E) on an assessment of maturity and integration risk of critical technologies. In addition, the DDT&E will be responsible for reporting on DT&E for major programs, developing DT&E policy and guidance, and providing a report on Service training of DT&E personnel, a joint biannual report with the Director Test Resources Management Center (TRMC), updating the T&E resource plan. Finally, the DDT&E, with the DOTE, will be jointly responsible for Test & Evaluation Master Plan approval.

Remedies

Expand and balance the government workforce

The key to every remedy discussed below is to reconstitute an experienced and capable government acquisition and T&E workforce. During a time of increased programmatic and technical complexity, there has been a loss of the most experienced management and technical workforce without an adequate replacement pipeline. Remedies for the acquisition problems must begin with reconstituting a trained and experienced government workforce, which includes program managers, contracting personnel, testers and evaluators, as well as the technical staff to support program offices. While I support the emphasis placed recently on systems engineering, domain subject matter experts are of equal importance, but they do not appear to enjoy the level of support needed. No amount of oversight at the systems integration level will compensate for a lack of technical domain expertise.

A steady career field flow must be reestablished to provide a constant replacement source as people progress through their careers and retire. A key element of this effort should be aggressive university recruiting campaigns similar to the ones that used to occur on an annual basis. The current job market presents a unique opportunity to recruit engineers and scientists, both entry level and mid-to-late career personnel. Several government organizations have begun to ramp up by wholesale conversion of support contractors to government positions. This may be a quick interim solution to temporarily acquire badly needed in-house skills, but forced large-scale conversions will continue the experience gap in the long run, as a large number of people being converted are retired government employees who will again retire in the near future. In recent meetings, both Service and OSD personnel have asserted that a major reason for reconstituting the government workforce is to save money on salaries. This is unequivocally the wrong motivation. The sole reason for the reconstitution should be to restore an in-house capability, so the government can perform its essential role in managing the acquisition process. This action will save an order of magnitude more money than any small and debatable savings accruing from lower salaries. In addition, professional services support contractors provide a valuable source of experienced support augmentation and should continue for government program office and test organizations. Unlike the government workforce, service contracts provide the flexibility to rapidly ramp up and down to smooth out the demand for coverage during surges and delays in

programs, as well as provide a quick reaction source for specialized expertise.

Another poor practice in some Service organizations is the elimination of the functional organizations that provide core cadres of domain expertise. The de-emphasis on government involvement was a factor in eliminating some functional organizations responsible for T&E oversight, policy, and procedures. Senior engineers at one major test organization affirmed that the erosion of the capability negatively impacted test planning and analysis of test results. The organization is no longer able to maintain their core domain expertise and mentor junior engineers. In addition, there was no longer an expert cadre to advance the state-of-the-art in test technology and data analysis software. Further, long-term permanent assignment to programs (rather than using a matrix approach) results in poor workforce utilization when long program delays occur. This poor practice has accelerated in the past 2 decades and should be reversed.

Improve the requirements process

A disciplined Analysis of Alternatives process should be employed to support requirements development, from capability needs identification to include system design and development as well as life cycle improvement. Emphasis must be placed on improving the processes for relating cost and mission effectiveness to system design, system performance and suitability. Suitability considerations have not been given the requisite priority in recent programs, which has had a severe adverse impact on availability, and sustainment costs. In some cases, programs have been stopped after years of development to belatedly address this critical area. Rigorous enforcement of key requirement thresholds, along with emphasis on performance in the intended mission environment, should be the norm when entering System Development and Demonstration. Issues that need to be addressed in relation to requirements setting include technology readiness, the translation of requirements into design criteria, with attention to testability at the subsystem and system levels, as well as defining thresholds for key performance parameters. Effective feedback processes are of special importance for spiral developments to identify enhancements which will improve performance and suitability. Improving the quality and speed of this feedback is increasingly important in responding to rapid changes in threat environments. Unfortunately, the deficiency reporting (DR) process, which was a major feedback mechanism during developmental test programs, has been allowed to atrophy in the last 15 years. Additionally, systematic feedback to the program offices after fielding is no longer used to the extent it was in the past. This continuing feedback is essential to improve system effectiveness, as well as to provide insights for spiral upgrades.

A disciplined process that develops a complete list of stable requirements is the indispensable starting point in the acquisition process. The requirements must be stated in unambiguous terms for design, developmental and test. They must be measurable, reasonable in terms of technology and cost, and capable of being tested and evaluated. The recent National Research Council study, led by Dr Paul Kaminski, is a superb roadmap for the requirements development process.[6]

Improve technology readiness

One of the many problems with recent systems is a lack of technology readiness for critical subsystems. Critical systems should be prototyped and alternative solutions evaluated on full-scale hardware. This evaluation must include experimentation or evaluation by government organizations who are not the primary technology advocates. Government test and evaluation involvement should be the norm in assessing Technology Readiness Level (TRL); i.e., system/subsystem model or prototype demonstration in a relevant environment. Recent consideration has been given to strengthening early involvement of the test community by reinvigorating the developmental test process. The government should focus on providing rigor to the TRL assessments in terms of test methodology as well as the test environment. There may be rare exceptions when a requirement is so pressing that higher than normal risks must be taken to design a system that incorporates an unproven technology. In those instances, a high priority, adequately funded, and closely monitored effort must be undertaken to mature the technology. This must include an early, rigorous assessment of the difficulties associated with the development effort as well as robust testing of the full-scale article to fully assess the requisite maturity. This is certainly not an area where the government hands-off approach, which has been in vogue recently, should be used. In addition, the TRL process has been focused on the technology of system components. Problems with manufacturing these components in production quantities have also led to significant cost growth for weapons systems. Previous legislation established the Manufacturing Technology Program to identify and develop initiatives to improve manufacturing quality, productivity, and technology. Consideration should be given to expanding the TRL process to evaluate the maturity of production methods by which systems are manufactured by embedding people with the requisite manufacturing expertise in the teams doing the technology development/maturization.

Restore meaningful government tester involvement

The role of the government in the test process is addressed in detail in the May 2008, DSB report on developmental test and evaluation.[3] With few exceptions, a government test organization should be the Responsible Test Organization (RTO). Over the last 2 decades, there has been a trend towards decreasing or eliminating active involvement by the government test community. This practice has included RTO designation to industry or government program offices; the latter often lacking in the requisite expertise to execute the RTO duties. Government tester involvement should start early and include participation in the test program for the Request for Proposal, as well as involvement in source selection. (W. D. Bell provides an excellent discussion of the rationale for government tester involvement in the requirements definition process).[7] When the program is on contract, the government test community should work with the prime contractor to develop the detailed test program, participate in technical reviews, and provide written reports periodically to the government program office on test progress. Red teams consisting of outside experts from other Services or Federally Funded Research & Development Centers (FFRDCs) should be used selectively for augmentation purposes.

Discipline Modeling and Simulation (M&S) investments

An overall M&S vision is required to identify where efforts should be focused, and to ensure that activities remain focused within that vision. Separate plans are needed for requirements definition, acquisition/test, training, and force structure evaluations, although there are common areas where cooperative M&S efforts would produce better and more cost-effective products. If high-priority M&S efforts within the overarching vision could be identified, it would be possible to establish requirements, understand what is currently available, and then determine shortfalls in M&S capability. One approach is exemplified by the Testing in a Joint Environment Roadmap, which was recently developed by DOT&E and approved by the Deputy Secretary of Defense. While focused on T&E usage, this capability would meet a significant percentage of contractor development and testing M&S requirements. The T&E roadmap identifies a requirement for a distributed live, virtual, constructive T&E capability; largely supported by existing models of friendly and threat systems. Much of this capability is expected to come from existing models of acquisition systems developed by program contractors, in conjunction with threat models available from the intelligence agencies. However, there has been virtually no effort to identify requirements for high-priority joint missions, determine what friendly and threat force representations are required, assess the availability of existing models that meet those requirements, and then use that information to define M&S shortfalls. In addition, there are insufficient mechanisms and processes to feed back data from operational tests and field exercises to further validate and refine models. Archiving mechanisms to store and locate verification and validation data for future applications are also needed.

Another issue that needs to be addressed is the availability and reuse of existing models to meet current requirements. Many models were developed by system contractors to meet specific needs. In many cases those models are proprietary; rarely with provisions for the models to be maintained current, so they represent a system in the field with normal improvements and modifications, or changes to the threats.

There are also supporting M&S requirements (engineering- and physics-based models) that are required in the validation of higher-level engagement models. Higher-level models, such as envisioned in the Testing in a Joint Environment Roadmap, could be used to identify areas with the greatest risk and uncertainty to identify areas where engineering and physics-based models are required. Any initial effort should be to review the past studies on M&S in the DoD and determine those requirements that could contribute the most to improving M&S capability. While most studies have identical or similar recommendations, the majority of those recommendations have not been implemented.

Focused M&S business plans must be developed, and the government must address issues relating to long-term configuration control, upgrades, ownership, and funding throughout the system lifecycle, to include training. In addition, addressing the requirements for a single joint mission doesn't capture requirements across several potential joint missions and scenarios. However, it would provide a starting point for future requirements and identify the most sensitive issues in implementation of the overall concept.

For any effort to improve the DoD's M&S capability, there should be an increased emphasis on reusable models, along with accessible supporting databases (radar cross-section, terrain, etc.) and documentation of verification and validation efforts.

Finally, an important consideration is the physical location of major simulation laboratories and related facilities. There are often valid reasons to locate a simulation capability at a contractor development facility to support initial development; however, this approach places limitations on the future utility and accessibility of the simulation, as well as the need to replicate parts of the simulation capability at a

government test facility or logistics center. Prior to making a decision regarding the location of simulation facilities for each major program, an assessment should be made as to the most cost-effective locations(s), taking into account follow-on and future programs. This decision-making process should include the appropriate Service Major Range & Test Facility Base (MRTFB) representatives, as well as the Test Resource Management Center TRMC).

Properly scope T&E

The lack of adequate test assets and funding for initial DT&E has a major adverse effect on developmental cost and schedule. There are numerous issues relating to DT&E funding. The weapons time lines for RDT&E continue to increase, driven by inadequate resourcing of the entire developmental and T&E process as well as the inclusion of immature technologies in systems. Inadequate funding of developmental testing, which includes the number and timing of test articles results in delayed identification and correction of problems, many of which are a normal part of a high-technology developmental program. Late identification results in more difficulty and expense involved in fixes. Most recent programs have had an inadequate number of test articles to execute a robust developmental test program in a timely manner. When there are an inadequate number of test assets, the developmental test program is drastically impacted, often for months, when a test vehicle must be laid up for a retrofit. By the time a program reaches the full-scale platform test phase, there is a huge cadre of test and test support personnel who cannot be efficiently used whenever a test program comes to a halt. The fixed cost of maintaining this cadre often exceeds the incremental variable cost per mission or test. This latter cost includes the cost for test range support and data processing. An exception is a test program where a high-cost asset is destroyed in every full-up test; e.g., missile testing. Adding test support personnel to accelerate a test program can be less expensive over the length of a program than allowing the program to stretch out over several years. More important, the normal problems that occur in every high technology developmental effort can be discovered and fixed earlier. Another factor in efficient testing is the availability of adequate test personnel and test facilities. The latter includes physical test support facilities and assets, instrumentation, and data processing. Numerous developmental programs have been delayed because of the lack of adequate facilities, capacity, and people with the appropriate expertise to accomplish the basic data processing tasks quickly, as well as an inadequate number of domain subject matter experts to analyze test results. Commercial programs routinely resource facilities and personnel to conduct testing on a multiple shift basis during critical phases of the developmental process.

The 1999 Defense Science Board (DSB) report on T&E addresses test cycle time reduction.[8] The following is a summary of the cycle time discussion from that report:

"DoD test programs undergo extensive technical and safety reviews, but little attention is paid explicitly to test cycle time reduction. There are several basic mechanisms by which test cycle-time can be reduced:

- reduce test program content;
- accomplish testing more effectively/efficiently;
- use test facilities and resources more intensively (e.g., multiple shifts, 7-day weeks, etc.);
- eliminate duplicative testing;
- budget and fund testing and test planning earlier in the program."

Full-scale testing in many DoD test programs is already at or near an irreducible minimum. A frequent choice of program managers is to further reduce testing or ignore test results (e.g., reliability), whenever a schedule or cost problem is encountered. There are numerous recent examples of this, which led to disastrous consequences; e.g., MV-22, theater high-altitude area defense (THAAD).

In summary, test cycle time reduction should be addressed at program initiation as well as periodically throughout every major program.

Conclusions

The last 20 years have seen dramatic changes in the DoD acquisition process in a time of unprecedented changes in the nature of the threat. In the aggregate, the implementation of the acquisition process changes had a negative impact during a period of increasing technological complexity. The current systemic acquisition problems are widely recognized by Congress as well as by some people in DoD. However, DoD took no substantive corrective action prior to the passage of the 2009 Weapons Systems Acquisition Reform Act. The required corrective actions are obvious, but it remains to be seen if OSD and the Services will revitalize the government workforce and re-instill the discipline necessary to remedy the many problems that exist today. ❑

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Endnotes

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